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Development of plasma display panel phosphors at National Physical Laboratory, New Delhi

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Plasma Display Panel (PDP) phosphors of three primary colours red, green and blue (RGB) have been developed for application in 50" HDPDP panel at SAMTEL. Three phosphors one each for red, green and blue was zeroed down. Synthesis processes by high temperature solid state reaction were optimized to achieve maximum quantum efficiency. We have also synthesized RGB nanophosphors by autocombustion method and compared with bulk RGB phosphor. Photoluminescence emission characteristics under VUV (172 nm) and UV (250 nm) excitation of the RGB phosphors show their suitability for PDP applications.

Keywords: Plasma display panel, Phosphors, Nanophosphors, Autocombustion

1 Introduction

In PDP panel, phosphors are excited by Vacuum Ultra Violet (VUV) light generated by a Xe-Ne plasma at 147 nm and 172 nm originating from Xe* and Xe_2* molecular excimer state[1]. For several considerations, 172 nm component is kept higher so that the developed phosphors should have excellent quantum efficiency at 172 nm VUV excitation wavelength. Phosphors of three primary colours-red, green and blue (RGB) are required for proper reproduction of pictures in TV screen. The rationale of selection of RGB phosphors for PDP is that they should be excitable by high energy from 6.2 to 8.8 eV, particularly 147 and 172 nm radiation emitted by plasma discharge of Xe-Ne gas mixtures[2,3]. In a PDP panel one pixel consists of three sub pixels (colour cell) of each primary colour. One colour cell can have 256 intensity levels and hence one pixel can produce 16.7 million colours. Variation in light intensity from a colour cell is accomplished by length of time the cell is ON during one TV frame. Since eye response (16 frames/sec) is slower than TV picture frequency (60 frames/sec), eye perceives different colours depending on how long each cell[4] is ON. Plasma response is very fast (10^{-6} s) and therefore, wavelength, intensity of emitted light, luminescence lifetime and stability of the phosphor are of prime concern while making a selection of phosphors for PDP application[5-8]. After a very careful study of literature[9-11] three phosphors (i) YAG:Eu^{3+} (red), (ii) YBO_3:Tb^{3+} (green) and (iii) $BaMgAl_{10}O_{17}$:Eu^{2+} (BAM) (blue) was zeroed down which are potentially useful for PDP applications to achieve targeted luminescence efficacy to the maximum extent.

2 Experimental Details

The phosphors were prepared by solid state reaction method at high temperature (up to 1500°C) in an atmosphere suitable for the valence state of the rare earth activator ion.

Red phosphor YAG:Eu^{3+} was synthesized from precursor materials Y_2O_3, Al_2O_3 and Eu_2O_3 at 1200°C in air to keep the Eu^{3+} state for red emission, Green phosphor YBO_3: Tb^{3+} was synthesized from precursor materials Y_2O_3, H_3 BO_3 and Tb_4O_7 at 1500°C in nitrogen atmosphere to keep the Tb^{3+} state for green emission and blue phosphor $BaMgAl_{10}O_{17}$:Eu^{2+} was synthesized from precursor materials $BaCO_3$, $MgCO_3$, Al_2O_3 and Eu_2O_3 at 1500°C in nitrogen and ammonia atmosphere to keep the Eu^{2+} state for blue emission.

In an attempt to reduce the particle size and investigate the luminescence characteristics, red, green and blue PDP phosphors were also synthesized by auto combustion process from nitrate precursor materials and using urea as fuel for auto ignition. Phase characterization was done by X-ray diffraction (XRD) analysis of the samples using Brucker-AXS D8 Advance Diffractometer (with DIFFRAC plus